Eurostrataform Analysis

Dr. W. Rockwell Geyer
Woods Hole Oceanographic Institution
Applied Ocean Physics and Engineering
98 Water Street, MS #12
Woods Hole, MA 02543
phone: 508-289-2868 fax: 508-457-2194 email: rgeyer@whoi.edu

Dr. Peter Traykovski
phone: 508-289-2638 fax: 508-457-2194 email: ptraykovski@whoi.edu

Award Number: N00014-04-1-0377

LONG-TERM GOALS

The long term goal of this project is to develop quantitative models of sediment transport, resuspension, deposition and accumulation on the continental margin.

OBJECTIVES

The objectives of this research program are: 1) to examine the sediment transport mechanisms on the Po delta, particularly the role of fluid mud flows on sediment dispersal; 2) to quantify the dynamics of the western Adriatic coastal current and its role in along-shelf and cross-shelf sediment transport; 3) to make rigorous comparisons between observations and models of the transport processes on the Po delta and the coastal current in order to improve the predictions of sediment transport and morphodynamic evolution.

APPROACH

This research effort includes data analysis and model-data comparison. The data were collected during the field portion of the Po and Apennine Sediment Transport and Accumulation (PASTA) study, principally from the period from October, 2002 to June, 2003. The data include moorings and tripods deployed along the western margin of the Adriatic, from the mouth of the Po River to Pescara, including instruments deployed by Woods Hole Oceanographic Institution, University of Washington, Institut de Ciències del Mar (Barcelona) and the U.S. Geological Survey. The data analysis also involves hydrographic data collected during several cruises over the same interval. Additional timeseries and shipboard data from the Adriatic Circulation Experiment in the northern Adriatic Sea are also used for characterization of the far-field conditions.

The data analysis addresses two main themes: 1) the processes affecting the suspended sediment distribution and dispersal in the vicinity of the Po delta, and 2) the dynamics and sediment transport associated with the western Adriatic coastal current. Traykovski is principally engaged in the investigations of the Po delta. He is focusing in particular on the occurrence of fluid-mud flows that lead to significant cross-isobath transport. Geyer (in collaboration mainly with Kineke, Mullenbach

Report Documentation Page

Form Approved
OMB No. 0704-0188

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE **30 SEP 2004**	2. REPORT TYPE	3. DATES COVERED **00-00-2004 to 00-00-2004**

4. TITLE AND SUBTITLE **Eurostrataform Analysis**	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Woods Hole Oceanographic Institution,,Applied Ocean Physics and Engineering,,98 Water Street, MS #12,,Woods Hole,,MA,02543**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**6**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

and Sherwood) is examining the dynamics of the coastal current and its associated sediment transport processes.

The model-data comparison involves detailed comparisons of model results with moored and shipboard observations. The initial comparisons are used to refine the model parameterizations and input functions (e.g., bottom boundary conditions for sediment resuspension). Subsequent comparisons address model skill in resolving variability in physical processes (velocity, salinity variations) and sediment transport processes. The model also provides a framework for kinematic and dynamical analysis, for example to assess the relative roles of pressure gradients and wind stress in driving the along-shelf motions.

WORK COMPLETED

Traykovski's analysis of the processes on the Po delta is essentially complete, and he has completed a draft of a manuscript describing these processes. Analysis of the coastal current dynamics is nearly complete. Sediment transport processes in the coastal current are still under investigation. The model-data comparison has been initiated, using various limiting cases for sediment resuspension parameterizations.

RESULTS

Po Delta Processes

Measurements from near-bottom tripods near the Tolle distributary of the Po River indicate the role of fluid-mud flows in contributing to cross-shore sediment fluxes. A major discharge event in November, 2002 (Figure 1) provided a large input of sediment to the Po delta. Several energetic wave resuspension associated with Scirocco winds (indicated by S1, S2 and S3 in Figure 1) caused intense resuspension of the bottom sediments, but the high concentrations were confined to the near-bottom waters due to weak currents in the upper water column. The across-shore velocity profiles in events S1 through S3 (Figure 1, lower left panel) show a jet of offshore flow as measured by the lower velocimeter at 11 cm above bottom, with weaker offshore flow above it. This is in contrast to the velocity profiles during Bora conditions (Figure 1, lower right), which display monotonically increasing flow from the seafloor to the height of the upper Velocimeter at 75 cmab. The offshore flows in lower 10 cm of the water column, during periods when high concentration layers are present are characteristic of wave supported sediment gravity flows. The down-slope (offshore) velocity observed at the top of the high concentration layer is due to the gravitational anomaly of the high concentration layer.

Traykovski applied the model that was developed to describe the gravity flows observed on the Eel River shelf, to determine whether the conditions at the mouth of the Po were consistent with the dynamics of that model, given the different depth and forcing conditions in this setting. Indeed the model produced results consistent with the observations—the smaller waves in the Adriatic cause these processes to occur at much shallower depths than on the Eel shelf, but the dynamical processes are similar.

Western Adriatic Coastal Current Dynamics and Sediment Transport

The western Adriatic Coastal Current is driven in part by freshwater buoyancy flux, but it is also driven by the net wind forcing in the Adriatic. The wind forcing is particularly important in context with the sediment transport processes, because it produces significantly greater bottom stress than the buoyancy-driven flow. The wind-driven circulation does not fit the simple models posed for upwelling and downwelling regimes on a straight coast, due to the complex spatial structure of the wind field as well as the semi-enclosed geometry of the Adriatic. As a consequence, the wind-forcing is non-local, with stresses from the northern Adriatic communicated to the coastal current via pressure gradients that set up along and across the basin. The along-shore pressure gradient within the coastal current produces a bottom Ekman layer, leading to a downwelling regime similar to a locally wind-forced regime, although without a surface Ekman layer.

The along-shelf sediment transport in the coastal current is clearly associated with Bora events (Figure 2), during which both the suspended sediment concentrations and the along-shelf velocities are maximal. The high concentrations occur due both to wave-induced and current-induced stresses, the latter being particularly important for getting the sediment high in the water column, where the along-shelf currents become significantly stronger. Analysis is underway to determine whether along-shelf variations sediment flux and the variations in timing of the flux can be used to determine the relative importance of sediment inputs from the Po and the Apennine rivers.

Unlike the Po delta, cross-margin transport along the Apennine margin is due mainly to Ekman-induced downwelling. The strength of the downwelling is enhanced by both the near-bottom stress and the stratification. The lateral salinity gradient associated with the river plume may inhibit cross-margin flux, although more analysis is required to determine whether trapping occurs as a result of the bottom density front.

Model-Data Comparison and Analysis

This part of the project is just getting underway. There are several preliminary results of this analysis. One is that the model provides a means of quantifying the mechanism of remote wind forcing, in providing spatially resolved pressure distributions related to the wind forcing. The model indicates a significant along-margin pressure gradient set up by Bora winds, which is a key driving variable for the southward flow in the coastal current. Preliminary sensitivity studies related to sediment resuspension are indicating the importance of a spatially and perhaps temporally varying bottom-resuspension condition. This will be one of the major challenges in achieving realistic simulations of the sediment transport in the Adriatic.

IMPACT/APPLICATIONS

The research is providing fundamental new insights about the dynamics and morphodynamics of river deltas and coastal current regimes. The identification of fluid-mud flows in a river delta region is of particular importance for mine countermeasures, navigation and acoustics. The coastal current dynamics and sediment transport processes have implications on larger spatial scales for the same naval issues.

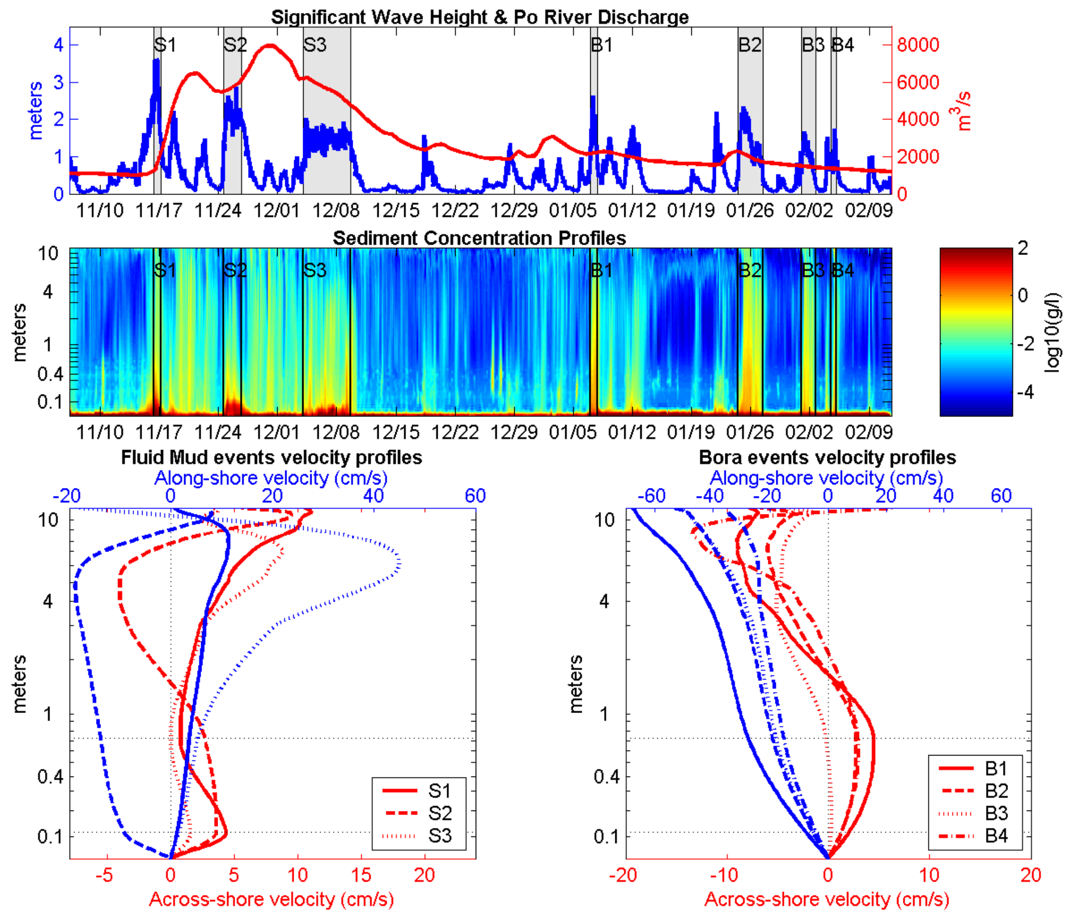

Figure 1.

[Timeseries observations of waves and river discharge (top panel), sediment concentration as color contours (second panel), and profiles of velocity during Scirocco (lower left) and Bora conditions (lower right). Note the log vertical scales that expand the bottom boundary layer. The horizontal dashed lines in the lower panels indicate the elevation of the Nortek velocimeters. The cross-shore velocities during the Scirocco events (red profiles) show maximum seaward flows at the near-bottom velocimeter, indicating gravity-driven flow by the thin, sediment-laden layer. The broader cross-shore flow during Bora events indicates more typical wind-forced downwelling, with much less cross-shore sediment flux.]

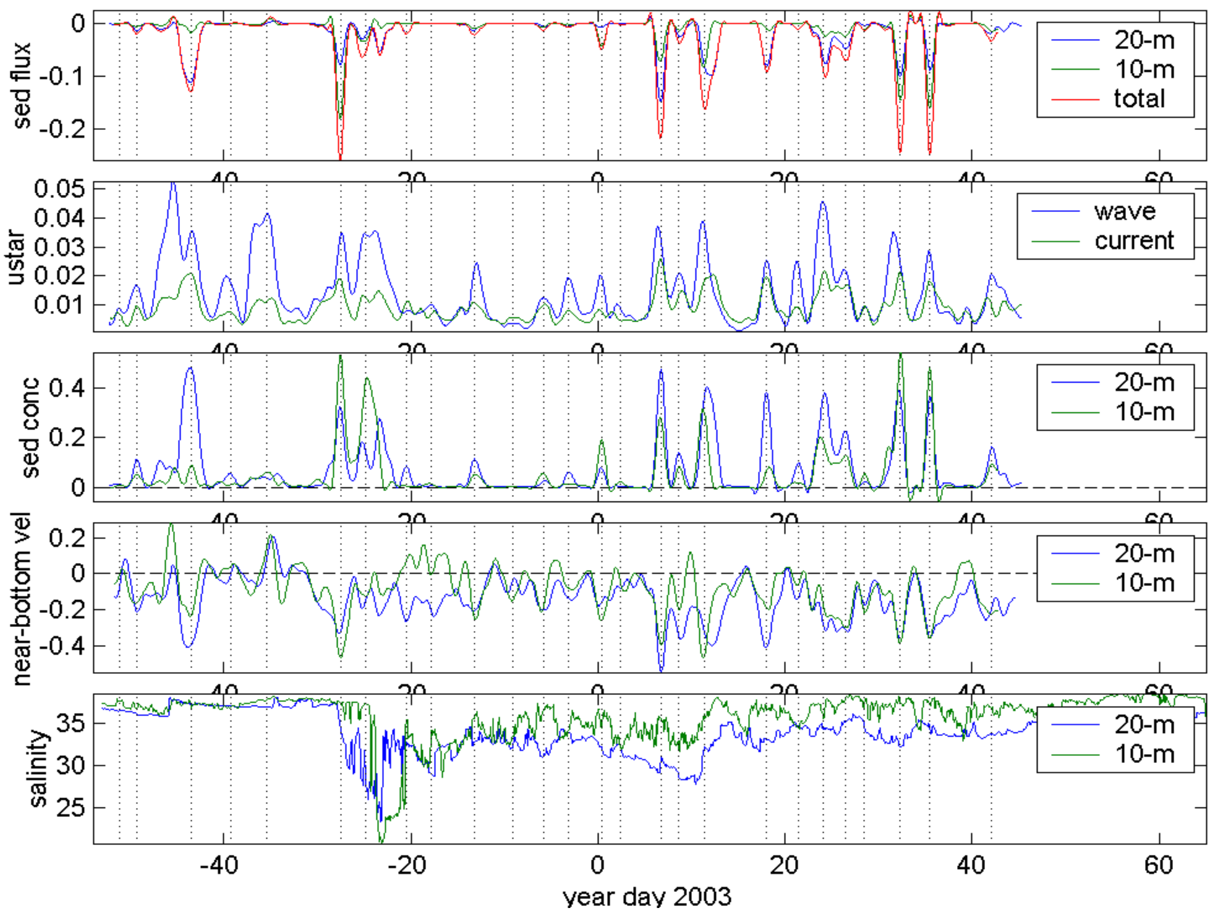

Figure 2.
[Timeseries of sediment flux and associated oceanographic parameters at the Chienti mooring site within the western Adriatic coastal current for the first half of the deployment, from early November, 2002 (year day -50) to mid-February, 2003(year day 65). The top panel is sediment flux in kg m^{-2} s^{-1}; the second panel is wave-induced and current-induced friction velocity in cm s^{-1}; the third panel is sediment concentration in kg m^{-3} (approximate, pending final calibration); the fourth panel is near-bottom, along-shelf velocity in m s^{-1}, and the bottom panel is near-surface salinity in psu. The major flux events all correspond to times of large waves and strong southward currents in the bottom boundary layer, forced by Bora winds in the northern Adriatic. All of the timeseries except for the salinity have been filtered to remove tidal and high-frequency fluctuations.]

PUBLICATIONS

Harris, C.K., P.A. Traykovski and W.R. Geyer, submitted. Flood dispersal and deposition on the northern California shelf. Submitted to Journal of Geophysical Research.